# *Discovering the Story: A City and Its Culture*

## *Solving a Problem to Tell the Story*

### A Mathematics Lesson for Grades 9-12

Based on *The Underground Railroad, 1893*
by Charles T. Webber

Charles T. Webber (1825-1911)
United States (Cincinnati)
***The Underground Railroad***, 1893
Subscription Fund Purchase, 1927.26

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## Concept Statement

Fleeing enslaved persons from southern and other states throughout the United States in the 1800s traveled miles, faced hardships and risked dangers in hopes of reaching destinations for personal freedom. Recreated scenarios provide a unit of study for students to examine mathematical problem-solving possibly faced by Underground Railroad (URR) participants –enslaved persons, abolitionists, "conductors" and slave owners. Observations and study of the C.T. Webber painting *The Underground Railroad* will aid teacher and students in their understanding of this historical undertaking.

The close proximity of a "safe house" and "URR guide" provided additional aid to fugitive slaves attempting to cross the Ohio River. Students will make use of a hypothetical scenario and the mathematical tool "slope" as a constant rate of change and Y intercept, to chart and determine the best location for crossing the river for fugitive slaves to arrive at the safe house without too much or too little traveling. Students will find a point of departure on the Kentucky side that is reasonable and accurate through application of algebraic representations and plotting distance and current. Students, by plotting graphs and charting the variables, will come to better understand the use of the mathematical tool "slope" for problem-solving and decision-making when studying change of authentic occurrences.

## Objectives

- Students will understand the concept of the Underground Railroad and its impact on personal freedoms.
- Students will draw conclusions about the freedom seekers through observations of the C.T. Webber painting *The Underground Railroad*.
- Students will identify and use relevant information found in visual art forms to confirm their conceptual understanding of the Underground Railroad.
- Students will employ mathematical processing skills for calculation of various word problems and visual representations based on Underground Railroad scenarios.

# Teacher Preparation

## Class Periods Required

1 to 2 (30-50 mins.) class periods for Pre-Videoconference Lesson Activities
1 (50 min.) class period for the Videoconference
1 to 2 (50-60 mins.) class periods for Post-Videoconference Lesson Activities
1 to 2 (50-60) periods for Art Enrichment Activity (optional)

## Background Information

Refer to Background Information for more on the painting *The Underground Railroad* and the artist who created it. This information also provides an historical background for the Underground Railroad and Cincinnati's involvement in this movement. This resource has been written for teachers to review before the lesson and then share with students.

## Video

Share the video that accompanies this lesson with your students prior to the videoconference. The video depicts the installation of an exhibit at the Cincinnati Art Museum that was inspired in part by C.T Webber's *The Underground Railroad* and the overarching concepts of courage and freedom.

Video Duration: approx. 6 minutes.

# Pre- Videoconference Lesson Activities

## Vocabulary

Definitions can be found in the Glossary on the *Discovering the Story* Website.

Abolitionist
Conductors
Courage
Equation
Fugitive
Line Graph
Safe House
Slave/Enslaved Person
Slope
Underground Railroad
Variable
Y Intercept

## Guiding Questions

- What was the Underground Railroad?
- What was the role of a "safe house" in the Underground Railroad system?
- What was the significance of the Ohio River to Underground Railroad functions?
- How do charts and graphs aid our understanding of significant events?
- How does a chart or graph help to illustrate interacting constant forces?
- What is the mathematical tool "slope" and how is its function useable in gathering data?

## Materials

- Print reproduction of *The Underground Railroad* – class set downloaded and printed from the *Discovering the Story* website
- Handouts (see pages 12 & 13)

## Procedure

***Teacher will:***

- Introduce the topic and concept of the Underground Railroad as a means for enslaved persons in the 1800s to gain personal freedom.
- Introduce a reproduction of the C.T. Webber painting *The Underground Railroad*.
  - Emphasize:
    - That the painting is one of many artist interpretations of the Underground Railroad
    - The introduction of identifiable characters--Levi Coffin, Catharine Coffin, Hannah Haydock and Thomas Haydock, and discuss their roles in the Underground Railroad
    - The role of the Ohio River and Ohio safe houses to this historical undertaking
- Introduce facts about the painting and the artist.
- Facilitate class discussion on the use of visual artifacts to prompt further investigation and examination into historical events and undertakings.
- Instruct students to observe the painting and infer information gained from pictorial depictions in the painting.
- Have students identify concepts about the Underground Railroad suggested in the painting's depictions.
- Have students discuss how information gathered from the painting can be used to further examine the concept of the Underground Railroad from a mathematical perspective.
- Tell the students that they will learn more about this painting in a videoconference with the Cincinnati Art Museum.
  - Teacher will need to explain and describe the function and process of videoconferencing.
  - Teacher will collect student questions to ask museum staff during the videoconference.
- Teacher will email questions to museum staff prior to the videoconference.

# Videoconference

## Objectives

- Students will interact with the Cincinnati Art Museum staff through a sixty-minute videoconference.
- Students will learn about Cincinnati's contribution to the Underground Railroad.
- Students will use Museum objects to reinforce activities completed in preparation for this videoconference.

## Concept

A videoconference conducted by the Cincinnati Art Museum staff extends student learning through emphasis on the viewing and discussion of art objects. During this videoconference with the Museum, students will explore Cincinnati's place in the story of the Underground Railroad movement and major tristate figures, such as Levi and Catharine Coffin, John Parker and John Rankin.

## Schedule

- **5 minutes** Introduction to CAM staff *(This is also buffer time in case of connection complications)*
- **10 minutes** Brief discussion of student pre-videoconferencing activities.
- **10 minutes** Museum staff will lead students in an in-depth investigation of C.T. Webber's painting *The Underground Railroad*
- **15 minutes** Museum staff will lead an interactive discussion with students on Cincinnati's place in the story of the Underground Railroad movement.
- **10 minutes** Questions and student sharing of art projects.
- **5 minutes** Closing *(This is also buffer time in case of connection complications)*

# Post- Videoconference Lesson Activities

## Materials

- Prepared "What if" question scenarios
- Graph paper
- Pencils and rulers
- Handouts A and B (see pages 12 & 13)
- Printed copy of *The Underground Railroad*, the painting by C.T. Webber

## PROCEDURE

*Teacher Will:*

- Facilitate class discussion to address the guiding questions:
  - How do charts and graphs aid our understanding of significant events?
  - How does a chart or graph help to illustrate interacting constant forces?
  - What is the mathematical tool "slope" and how is its function useable in gathering data?
- Introduce or review the concepts of algebraic equation, "slope," "Y intercept" and rates of change.
- Review mechanics of a river's flow and its variable for change.

(Note: Students may have the option of performing calculations with use of a graphing calculator and/or electronic spreadsheet.)

Students Will:

- Understand the concept and mechanics of a river's flow, and variables that lend to the flow's rate of change.
- Apply functional use of the mathematical tool, "slope," in the study of rates of change to a hypothetical problem scenario based on the Underground Railroad historical event.

1. Read the narrative of a night escape on the Underground Railroad.
   "It is raining intensely and the Ohio River is flowing extremely fast. In fact, for every seven feet one paddles forward, the river takes them back five feet downstream. This makes it impossible to cross directly in front of an Underground Railroad safe house. It will be necessary to cross the river further upstream in order to travel safely and meet the "conductor" on the other side at a designated location. If the river is seventy-six feet wide, about how far upstream must the enslaved fugitive cross to reach safe passage? "

2. On large chart paper, plot the "slope" if X is 5, Y is 7, and if X is 25 and Y is 35. (Plot the two ordered given pairs.) (7, 5 and 35, 25). See Handout A.

3. Use a graphical representation to complete the chart. (Forward 7, push down 5). See Handout B.

4. Ask follow-up questions.
   - If the river was 50 foot wide or 60 foot wide, how far upstream would one have to cross? (Teacher may choose to provide students with multiple scenarios with changing variables.)

- In a real-life scenario, would the rivers always flow at a constant rate, or would it vary? Would the answer to this question have significance for actual problem-solving?
- Would one's ability to paddle fast or slow have significance for actual problem-solving?

5. Use any or all of the following word sheets to practice plotting points on graphs (X, Y).

6. Use graphs to complete the charts.

7. Discuss implications of the various relationships that were plotted. Discuss why the need for accuracy is important.

8. Referencing the C.T. Webber painting, discuss travels and dangers for fugitive slaves, and what factors needed to be considered before risking the flight to freedom, and in particular the crossing of rivers.

## Assessment Objectives

Teacher and students will make use of a scoring rubric to evaluate student understanding and mastery of the process graphing data on charts, as well as correct computation for problem solving. *(Teacher and student generated)*

## Suggested Teacher Resources

**Books**

Hudson, J. Blaine. *Fugitive Slaves and the Underground Railroad in the Kentucky Borderland.* Jefferson, NC: McFarland & Company, Inc., 2002.

**Websites**

Purplemath-Your Algebra Resource

About.com on African-American History
The Fugitive Slave Act
Safe Passages
National Underground Railroad Freedom Center
National Geographic's Underground Railroad website

Library of Congress/American Memory Collection

# Academic Content Standards

## National Standards: Mathematics

**Standard 2:** Understands and applies basic and advanced properties of the concepts of numbers.

**Grades:** 9-12

**Benchmark 1:** Understands the properties (e.g., relative magnitude, density, absolute value) of the real number system, its subsystems (e.g., irrational numbers, natural numbers, integers, rational numbers) and complex numbers (e.g., imaginary numbers, conjugate numbers).

**Standard 8:** Understands and applies basic and advanced properties of functions and algebra.

**Grades:** 9-12

**Benchmark 2:** Uses expressions, equations, inequalities and matrices to represent situations that involve variable quantities and translates among these representations.

**Benchmark 4:** Understands properties of graphs and the relationship between a graph and its corresponding expression (e.g., maximum and minimum points).

**Benchmark 7:** Uses a variety of models (e.g., written statement, algebraic formula, table of input-output values, graph) to represent functions, patterns and relationships.

**Benchmark 11:** Uses a variety of methods (e.g., with graphs, algebraic methods and matrices) to solve systems of equations and inequalities.

**Standard 6:** Understands and applies basic and advanced concepts of statistics and data analysis.

**Grades:** 9-12

**Benchmark 1:** Selects and uses the best method of representing and describing a set of data (e.g., scatter plot, line graph, two-way table).

**Benchmark 9:** Understands that making an inference about a population from a sample always involves uncertainty and the role of statistics is to estimate the size of that uncertainty.

**Visual Art:**

**Standard 4:** Understands the visual arts in relation to history and cultures.

**Grade:** 9-12

**Benchmark 1:** Knows a variety of historical and cultural contexts regarding characteristics and purposes of works of art.

**Benchmark 2:** Knows the function and meaning of specific art objects within varied cultures, times and places.

**Benchmark 3:** Understands relationships among works of art in terms of history, aesthetics and culture.

## Ohio Standards: Mathematics

**Number, Number Sense and Operations:** Students demonstrate number sense, including an understanding of number systems and operations and how they relate to one another. Students compute fluently and make reasonable estimates using paper and pencil, technology-supported and mental methods.

Grades 9-10

**Benchmark C:** Applies properties of operations and the real number system, and justifies when they hold for a set of numbers.

**Benchmark G:** Estimates, computes and solves problems involving real numbers, including ratio, proportion and percent, and explains solutions.

Grades 11-12

**Benchmark D:** Demonstrates fluency in operations with real numbers, vectors and matrices, using mental computation or paper and pencil calculations for simple cases and technology for more complicated cases.

**Patterns, Functions and Algebra:** Students use patterns, relations and functions to model, represent and analyze problem situations that involve variable quantities. Students analyze, model and solve problems using various representations such as tables, graphs and equations.

Grades 9-10

**Benchmark D:** Uses algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.

**Benchmark E:** Analyzes and compares functions and their graphs using attributes, such as rates of change, intercepts and zeros.

**Benchmark F:** Solves and graphs linear equations and inqualities.

**Benchmark H:** Solves systems of linear equations involving two variables graphically and symbolically.

**Benchmark I:** Models and solves problem situations involving direct and inverse variation.

**Benchmark J:** Describes and interprets rates of change from graphcial and numercial data.

Grades 11-12

**Benchmark A:** Analyzes functions by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior.

**Data Analysis and Probability:** Students pose questions and collect, represent, interpret and analze data to answer those questions. Students develop and evaluate infrerences, predictions and arguments that are based on data.

Grades 9-10

**Benchmark F:** Constructs convincing arguments based on analysis of data and interpretation of graphs.

Grades 11-12

**Benchmark A:** Creates and analyzes tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.

**Mathematical Processes**: Students use mathematical processes and knowledge to solve problems. Students apply problem-solving and decision-making techniques, and communicate mathematical ideas.

Grades 9-10

**Benchmark A:** Formulates a problem or mathemetical model in response to a specific need or situation, determines information required to solve the problem, chooses method for obtaining this information and sets limits for acceptable solution.

**Benchmark B:** Applies mathematical knowledge and skills rountinely in other content areas and practical situations.

**Benchmark C:** Recognizes and uses connections between equivalent representations and related procedures for a mathematical concept; e.g., zero of a function and the x-intercept of the graph of the function, etc.

Grades 11-12

**Benchmark A:** Constructs algorithms for multi-step problems and non routine problems.

**Benchmark B:** Applies reasoning processes and skills; constructs logical verifications or counter examples to test conjectures and to justify or refute algorithms and solutions to problems.

**Benchmark C:** Assesses the adequacy and reliability of information available to solve a problem.

**Benchmark D:** Selects and uses various types of reasoning and methods of proof.

Visual Arts

**Historical, Cultural and Social Contexts:** Students understand the impact of visual art on the history, culture and society from which it emanates. They understand the cultural, social and political forces that, in turn, shape visual art communication and expression. Students identify the significant contributions of visual arts to cultural heritage. They analyze the historical, cultural, social and political contexts that influence the function and role of visual art in the lives of people.

Grades 9-12

**Benchmark A:** Explains how and why visual art forms develop in the contexts (e.g., cultural, social, historical and political) in which they are made.

**Creative Expression and Communication:** Students create artworks that demonstrate understanding of materials, processes, tools, media, techniques and available technology. They understand how to use art elements, principles and images to communicate their ideas in a variety of visual forms.

Grades 9-12

**Benchmark A:** Demonstrates mastery of materials, concepts and personal concentration when creating original artworks.

**Connections, Relationships and Applications:** Students connect and apply their learning of visual art to the study of other arts areas and disciplines outside the arts. They understand relationships between and among concepts and ideas that are common across subjects in the curriculum. Students recognize the importance of lifelong learning and experience in visual art.

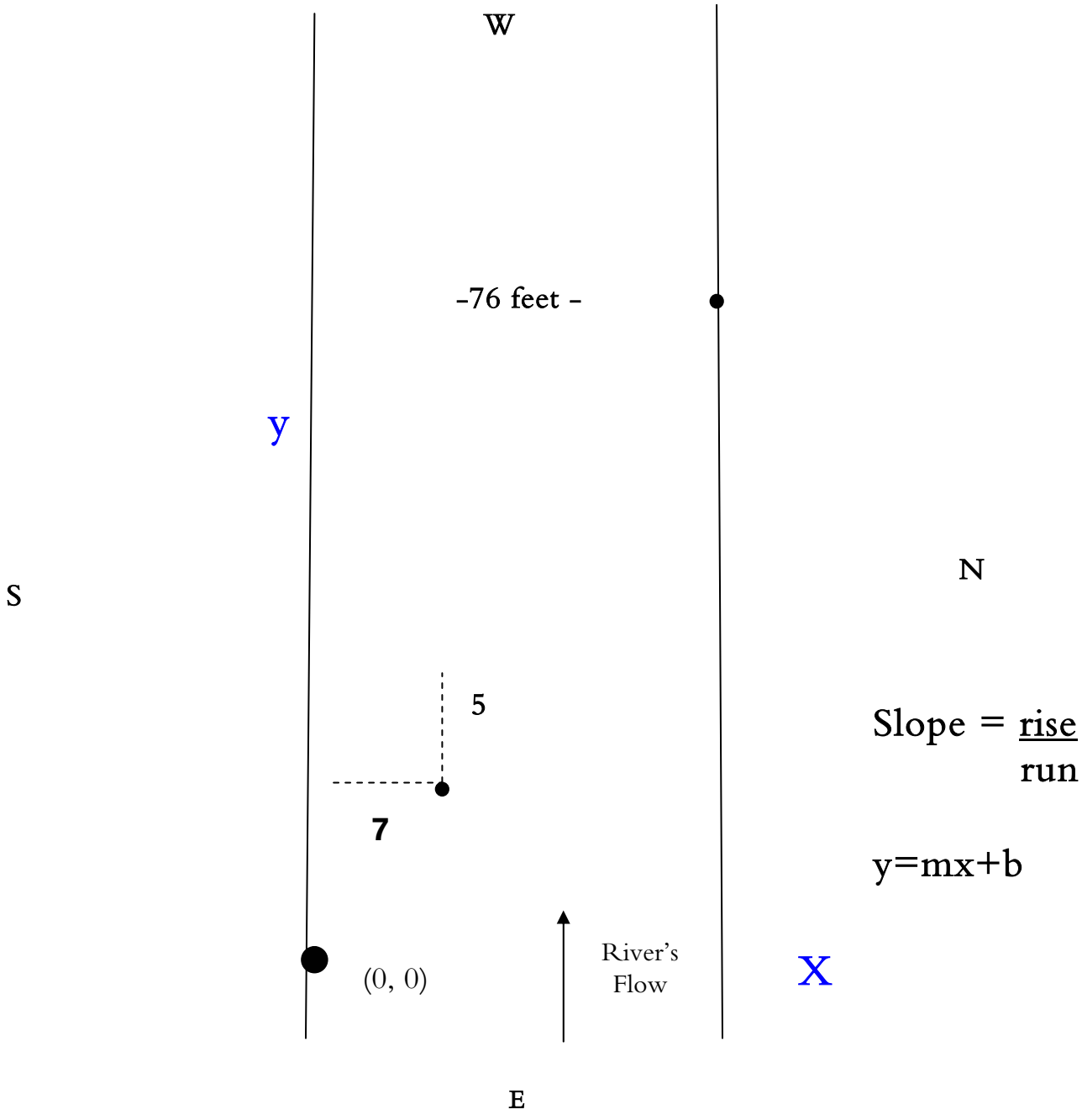
Grades 9-12

**Benchmark B:** Formulates and solves a visual art problem using strategies and perspectives from other disciplines. [Relationship to other subjects in curriculum.]

HANDOUT A

It is raining intensely and the Ohio River is flowing extremely fast. In fact, for every seven feet one paddles forward, the river takes them back five feet downstream This makes it impossible to cross directly in front of an Underground Railroad safe house .It will be necessary to cross the river further upstream in order to travel safely and meet the "conductor" on the other side at a designated location. If the river is seventy-six feet wide, about how far upstream must the enslaved fugitive cross to reach safe passage?

**Plot the "slope" if X is 5, Y is 7, and if X is 25 and Y is 35. (Plot the two ordered given pairs.) (7, 5 and 35, 25).**



HANDOUT B

Transparent Overlay for graphing